POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 1994

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ABSTRACT

Sixty-three different humpback whales (*Megaptera novaeangliae*), including 9 calves (14.3 %) were photographically identified in Glacier Bay and Icy Strait between May 26 and August 31, 1994. Of these whales, 21 (33 %) were seen solely in Glacier Bay, while 31 (49%) were seen only in Icy Strait. Eleven whales (17 %) were common to both areas. Ten (31%) of the Glacier Bay whales and 13 (31 %) of Icy Strait whales were resident for more than 20 days. Whales were found in an average water depth of 36.6 fathoms (SD = 24.5, range 5-180), and in a mean sea surface temperature of 10.4 °C (SD =1.9, range 7.9-15.6). Peak whale use of Glacier Bay occurred in July, with most activity concentrated in Whidbey Passage and the east side of Glacier Bay. Icy Strait whales were distributed widely from Idaho Inlet to Pleasant Island in June, July and August with a moderate concentration of whales near Point Adolphus. Two whales (#1019 and #1064) that had not been identified since their birth year were re-sighted in the study area.

INTRODUCTION

This report summarizes National Park Service (NPS) humpback whale population monitoring in Glacier Bay and Icy Strait during the late spring and summer of 1994. The whales that use Glacier Bay and Icy Strait are part of the southeastern Alaska feeding herd, one of several geographically-distinct feeding areas in the North Pacific (Baker et al. 1986). Mark-recapture estimates indicated that the mean annual population of humpback whales was 404 (95% confidence limits 350 to 458) in southeastern Alaska between 1979 and 1992 (Straley 1994). North Pacific humpback whales migrate annually to winter breeding and calving grounds in the Hawaiian Islands, Mexico or Japan (Baker et al. 1986; Urban and Aguayo 1987; Darling 1991; Calambokidis et al. 1993), although most southeastern Alaska humpbacks appear to use the Hawaii wintering grounds.

Humpback whales have inhabited Glacier Bay since at least the 1930's (Vequist and Baker 1987), and have been observed and individually identified since the early 1970s (Jurasz and Palmer 1981). In 1978, 17 of the 20 whales that Jurasz observed in Glacier Bay departed abruptly (Jurasz and Palmer 1981), causing great concern that the departure had been caused by increased vessel traffic. Other scientists asserted that the decline in whale numbers could have been caused by a natural fluctuation in whale prey abundance. Studies of whale prey (Wing and Krieger 1983; Krieger and Wing 1984; Krieger and Wing 1986), behavior (Baker et al. 1982; Baker et al. 1983; Baker and Herman 1989) and underwater acoustics, (Malme, Miles and McElroy 1982; Miles and Malme 1983), conducted to resolve this issue, corroborated some aspects of each hypothesis for the whales' 1978 departure.

In order to achieve satisfactory management of whale / vessel interactions in Glacier Bay, the NPS consulted with the National Marine Fisheries Service (NMFS) under section VII of the Endangered Species Act on three occasions between 1979 and 1993, resulting in Biological Opinions in 1979, 1983 and 1993. The NPS has enforced regulations that prohibit whale approach, regulate vessel numbers and operations in Glacier Bay since 1980 (Federal Register 45 32228, May 15, 1980) and has monitored humpback whale population characteristics from June 1 to August 31 since 1985. The systematic studies of individually-identified humpback whales in Glacier Bay constitute one of the longest and most complete time-series of data on a living baleen whale population (Jurasz and Palmer 1981; Perry et al. 1990).

Under the NPS whale monitoring program, humpback whale surveys have been conducted with consistent methods and amounts of effort each year, to ensure comparability between years. Various parameters are used to characterize the humpback whale population, including the number of individuals identified, residence times, spatial and temporal distribution, calf production and feeding behavior. Human / whale interactions including strandings, entanglements in fishing gear and vessel disturbance are also documented. The number of whales using Glacier Bay and Icy Strait each year has ranged from 41 to 68 (summarized in Gabriele 1993). Gabriele and Straley (1993) found that variability in whale counts between 1985-1992 indicated annual fluctuations in local whale abundance not attributable to minor variability in monitoring effort. Sighting histories of individual whales have demonstrated a great deal of interchange between Glacier Bay and Icy Strait within and between years (Gabriele and Straley 1993). Other studies documented exchange between Glacier Bay / Icy Strait and other areas in southeastern Alaska, (Baker et al. 1986; Baker et al. 1990; Straley and Gabriele 1993; Straley 1994), suggesting that the number of whales in all of these areas is interdependent.

The availability of whale prey in southeastern Alaska appears to be integrally linked to whale movement and in and around Glacier Bay. Previous studies indicated that the primary prey item available to Icy Strait whales was herring (*Clupea harengus*) (Wing and Kreiger 1983; Kreiger and Wing 1984, 1986), while in Glacier Bay schooling fish such as capelin (*Mallotus villosus*), juvenile pollock (*Theragra chalcogramma*), and sand lance (*Ammodytes hexapterus*) (Kreiger and Wing 1984, 1986) were primary prey. Monthly oceanographic surveys in 1993 and 1994 (National Biological Survey, unpublished data), and expansion of the whale monitoring protocol (Gabriele 1993) have begun to document the physical characteristics of Glacier Bay and Icy Strait waters and will improve understanding of humpback whale habitat.

Individual sighting histories generated by NPS humpback whale monitoring and work by other researchers have produced valuable data on calving intervals (summarized in Straley 1994), calf return and recruitment in southeastern Alaska. At least 13 individual whales that were first identified as calves have returned to Glacier Bay / Icy Strait in one or more years (Gabriele 1993; Straley 1994). Cow #353, identified as a calf in 1984, has returned to the study area in many successive years, and was observed with her first calf in 1992 (Perry et al. 1985; Gabriele 1992) and another calf in 1994. The proportion of calves each year in the Glacier Bay / Icy Strait population oscillates annually, ranging from 4.5% to 17.6%, coincident with fluctuations in local whale abundance (Baker 1986; Gabriele 1992). Reproductive histories of individual females and their offspring are currently the best available means of determining the reproductive parameters that will determine future population viability.

METHODS

Vessel Surveys: The 1994 humpback whale monitoring program concentrated in Glacier Bay and Icy Strait from late May through August. Humpback whales were observed and photographed from a 17' Boston Whaler powered with a 60 hp outboard engine. The main body of Glacier Bay (a rectangle defined by four corners: Bartlett Cove, Point Carrolus, Geikie Inlet and Garforth Island) was surveyed approximately 3 days per week. Surveys of the upper bay were conducted approximately bi-weekly or when whale sightings were reported by other vessels. Upper bay surveys extended as far north as Russell Island in the West Arm and Adams Inlet in the East Arm. Icy Strait surveys were performed approximately once per week, with the greatest survey effort along the shoreline of Chichagof Island from Mud Bay to Burger Point, although several surveys included Lemesurier Island and westward to the mouth of Idaho Inlet. Surveys of the north and west shorelines of Pleasant Island were conducted as time and weather permitted. Icy Strait surveys also resulted in a survey of the mouth of Glacier Bay, because that area is crossed in transit from Bartlett Cove to Icy Strait.

Surveys were not conducted in the same area on consecutive days to minimize the potential impact that monitoring efforts might have on the whales. On occasions when circumstances such as time, weather, or the presence of other vessels prevented whale identification photographs from being taken, consecutive surveys of the same area were made. Latitude and longitude positions of pods were determined using a Magellan NAV1000 Global Positioning System (GPS) at the start of each observation. Table 1 shows the number of surveys per month in Glacier Bay and Icy Strait in from 1985-1994. Table 2 shows 1985-1994 hours of search and observation time.

Individual Identification: Whale fluke photographs were taken with a Nikon 8008 camera equipped with a motor drive, databack, and 300 mm lens. High speed (400 ASA pushed to 1600) black and white film was used to obtain clear photographs of the ventral surface of the tail flukes of each whale. Each whale's flukes have a distinct black and white pigment pattern that allows individual identification (Jurasz and Palmer 1981; Katona et al. 1979). Photographs of the dorsal fin supplemented the identification of individuals. The film was processed and printed by Panda Lab in Seattle, Washington. Contact sheets were analyzed to determine the dates that each whale was photographed. The season's best photograph of each individual was printed and catalogued. A copy of each print was submitted to the North Pacific humpback whale photographic archive (Mizroch, Beard and Lynde 1990). Sighting data including whale identity, pod size, and location were added to a Foxpro computer database containing Glacier Bay and Icy Strait whale sighting histories from 1977 to 1994.

Photographs of individuals were compared to previous Glacier Bay photographs and to available catalogs (Jurasz and Palmer 1981; Perry et al. 1985; Perry et al. 1988; von Zeigesar 1992) to determine the identity and past sighting history of each whale. Many whales are referred to by an identification number issued by the Kewalo Basin Marine Mammal Laboratory (KBMML) catalog of North Pacific humpback whales (Perry et al. 1988). Whales first photo-identified by Jurasz and Palmer (1981) are also referred to by their nicknames. Identification numbers smaller than ID# 950 coincide with those in the KBMML catalog, but those ID#s greater than 950 are unique to Glacier Bay National Park's catalog. Whales that were previously unidentified in Glacier Bay and Icy Strait were assigned a temporary identification code, for example GB 93-01, indicating the year (1993) and location (GB) of the sighting. Temporary codes were replaced with permanent identification numbers if the whale was seen more than once in a season, or if it had been identified elsewhere or in previous years. Calves were assigned ID#s if their tail flukes were adequately photographed for individual identification.

Whale Counts: After all photographs were analyzed, the number of distinct individual whales in the sample was counted. Separate counts were made of Glacier Bay and Icy Strait, for the total monitoring period and for a 'standardized period' (after Perry et al. 1985), from 9 July to 16 August. The standardized period was chosen by Perry and co-workers (1985), to coincide with the study dates in 1982-1984, so that valid comparisons of counts between years could be made. Although the standardized period is substantially shorter than the current NPS monitoring season, and the beginning and ending dates have no particular biological significance, the standardized counts tend to reflect trends in total counts relatively

Gabriele and Straley 1993). Continued use of the 'standardized period' is currently the only way of comparing whale counts between 1982-1992 (Gabriele and Straley 1993).

Habitat Characteristics and Prey Assessment: Surface temperature and water depth were measured with a Raytheon V850 dual-frequency color video echo-sounder at the start of each pod observation. The temperature sensor was calibrated with a scientific thermometer and agreed within .1 °C. Depth measurements were rounded to the nearest fathom. The depth, density and morphology of prey patches appearing on the echo-sounder screen were qualitatively described in the observer's field notes. Color slides (200 ASA, shutter speed 1/30) of the echo-sounder screen were taken to capture particularly interesting images. Gain and chart-speed settings were standardized (gain for 50 kHZ and 200 kHz transducers were set at 75%, chart speed was set at 9) to ensure that images observed on different sampling occasions would be comparable. Distinguishing between fish and planktonic targets was possible because 200 kHz echoes preferentially reflected fish, while the 50 kHz echoes reflected plankton. When possible, prey type was determined visually or sampled with a dip net in the vicinity of feeding whales.

Table 1. Number of humpback whale survey days per month in Glacier Bay and Icy Strait, 1985-1994.

Year	Glacier Bay					Icy Strait				
	May	June	July	Aug	Sept	May	June	July	Aug	Sept
1985	0	10	11	10	0	0	7	4	3	1
1986	0	13	17	6	0	0	5	3	6	2
1987	3	12	12	5	1	2	5	7	7	2
1988	0	11	12	12	7	0	5	7	5	3
1989	3	17	14	16	1	1	6	6	7	4
1990	6	16	18	14	0	4	5	6	8	0
1991	7	14	17	13	6	3	7	6	4	3
1992	3	19	17	12	7	2	4	5	4	1
1993	2	10	13	7	1	1	3	3	5	1
1994	1	9	10	13	1	0	5	4	8	1

Table 2. **Total search and encounter time in Glacier Bay (GB) and Icy Strait (IS); 1985 and 1988-94.**

Year	GB (hrs)	IS (hrs)	Total (hrs)	Total Whale Count (GB and IS)
1985	234	92	326	41
1986	-	-	-	51
1987	-	-	-	59
1988	199	108	307	55
1989	231	123	354	42
1990	215	115	330	50
1991	256	100	356	52
1992	248	71	319	68
1993	192	62	254	51
1994	171	92	263	63

RESULTS

Counts: A total of 63 individual humpback whales were photographically identified in Glacier Bay and Icy Strait between 26 May and 31 August 1994 (Table 3; Appendix A). Of this total count, 11 whales (17 %), including 2 cow/calf pairs, were common to both areas. Thirty-one whales, including 5 cow/calf pairs were sighted exclusively in Icy Strait and 21 (including 1 cow/calf pair) were observed exclusively in Glacier Bay (Table 3). Limiting the count to those whales seen during the standardized period from 9 July to 16 August (Perry et al. 1985), yielded a standardized count of 17 whales in Glacier Bay and 29 in Icy Strait (Table 3). For Icy Strait and Glacier Bay combined, there were 44 whales (including 8 cow/calf pairs) observed during the standardized period. Many whales identified this summer are individuals that return annually to the Glacier Bay / Icy Strait region (Jurasz and Palmer 1981; Perry et al. 1985; Baker 1986, 1987; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991; Gabriele 1992; Gabriele 1993).

Seasonal Distribution: Figure 1 shows the approximate locations of whales identified in surveys of Glacier Bay and Icy Strait. Glacier Bay whale distribution was comparable to previous years, although Sitakaday Narrows appeared to receive somewhat less whale activity than it typically does. In June, whales were feeding near shore primarily in the lower

Table 3. Standardized and total counts of humpback whales in Glacier Bay and Icy Strait: 1982-1994.

Year	Glacier Bay		Icy Strait		Glacier Bay & Icy Strait	
	Standardized Count	Total Count	Standardized Count	Total Count	Standardized Count	Total Count
1982	22	22	5	15	33	33
1983	10	10	9	9	17	17
1984	24	25	21	22	39	39
1985	10	15	19	30	27	41
1986	26	32	27	35	42	51
1987	28	33	34	48	49	59
1988	17	39	29	36	41	55
1989	20	24	19	30	33	42
1990	16	26	24	34	36	50
1991	16	19	34	40	45	52
1992	27	35	38	51	51	68
1993	23	31	25	33	42	54
1994	17	32	29	42	44	63

Note: Total counts refer to the number of whales (adults and calves) identified during the entire monitoring season. Standardized counts refer to the number of whales sighted between 9 July and 16 August each year. The combined count for Glacier Bay and Icy Strait is typically slightly smaller than the sum of Glacier Bay and Icy Strait counts, because some whales are identified in both areas.

bay, Whidbey Passage, Geikie Inlet, near Leland Island and the Marble Islands. The largest aggregation of whales in Glacier Bay occurred in Whidbey Passage in early to mid-July, while other whales remained scattered throughout the bay. At least one whale (whale #1018 was identified) was sighted repeatedly north of Russell Island, and in Tarr Inlet, as little as 1/2 mile from Grand Pacific and Margerie glaciers in July. There were repeated sightings of a single whale, (whale #1012 was identified on 3 occasions, although other individuals may also have been using the area) feeding very near shore at South Marble Island throughout June, July and August. In August, the lower bay and the east side of the bay near Flapjack, Marble and Sturgess Islands were the most active, with small numbers of whales scattered in the vicinity of Geikie Inlet and Tidal Inlet. The highest number of whales identified in a single acier Bay survey was 8, on 30 June and 11 July.

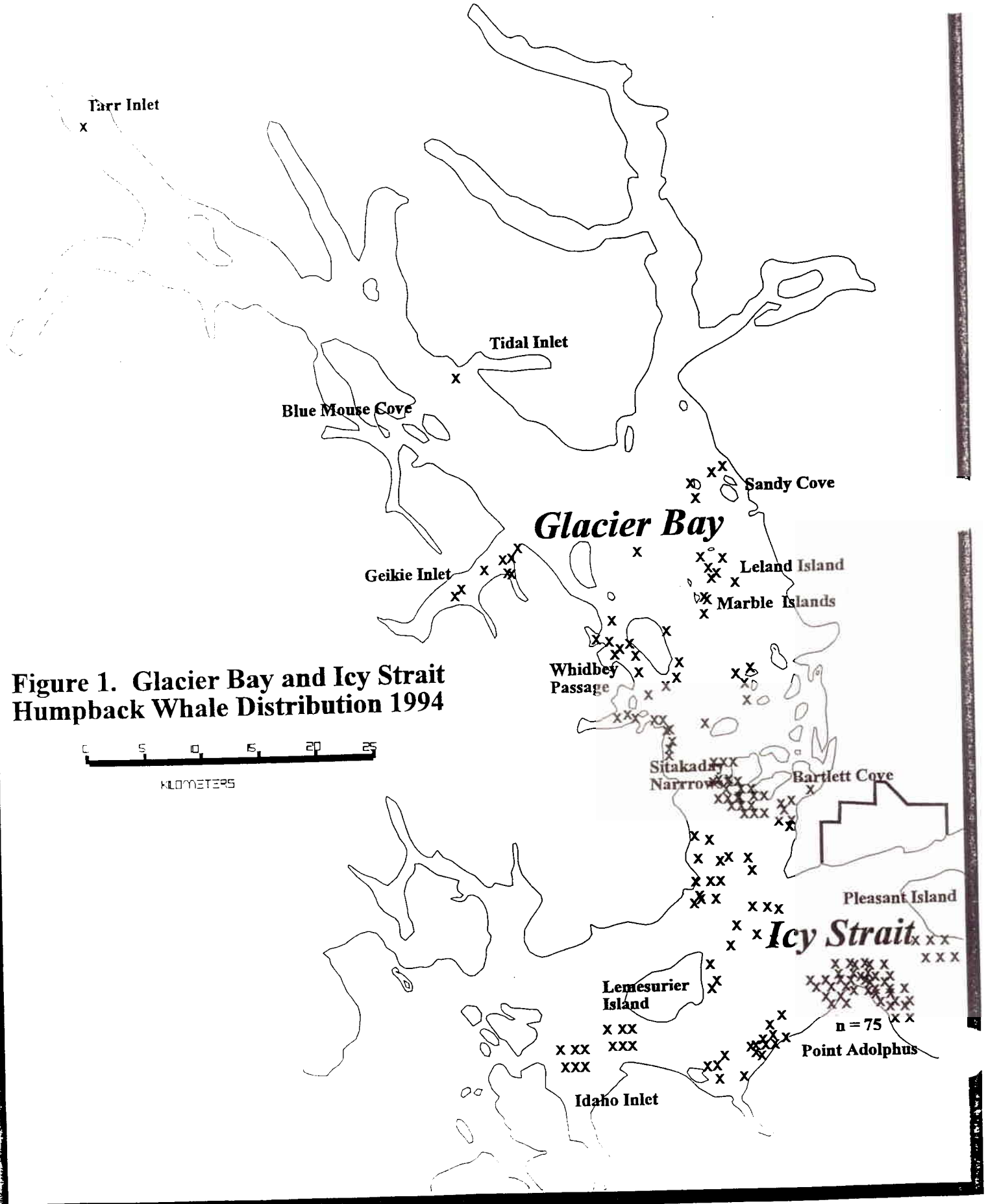

Figure 1. Glacier Bay and Icy Strait Humpback Whale Distribution 1994

Icy Strait whales were dispersed over a large area with a moderate degree of concentration near Point Adolphus. Throughout the season, whales appeared to scattered widely across Icy Strait from Point Gustavus to Idaho Inlet, Mud Bay, Pinta Cove, Pleasant Island and Lemesurier Island. From late June to mid-July, an aggregation of 10-15 whales was reported at the mouth of Idaho Inlet. Identification photographs revealed that many of these individuals were typically resident near Point Adolphus in other years. The highest number of whales identified in an Icy Strait survey was 17, on 13 July.

Local Movement and Residency: Whale movement between Glacier Bay and Icy Strait was relatively uncommon. Eleven whales (17% of all identified whales) were sighted in both Icy Strait and Glacier Bay, with 7 individuals (11%) including 2 cow/calf pairs, making one or more round trips between areas (Appendix 1). Ten (31%) of the 32 whales that entered Glacier Bay remained 20 or more days, long enough to be considered resident (Baker et al. 1983). Five additional whales, including 2 cow/calf pairs, were present in Glacier Bay nearly long enough to be considered resident, and would have been considered resident if data from September was included in this analysis (Appendix 1, NPS unpublished data). Using the same 20 day residency criterion, 13 (39%) of the 33 Icy Strait whales were considered resident in that area during the study.

Habitat Characteristics and Prey Assessment: Sea surface temperature and water depth were also measured for 84 of 122 pods observed in 1994. Humpback whale pods were found in waters with sea surface temperatures ranging from 7.9 to 15.6 °C with an average temperature of 10.4 °C (SD = 1.9), and modal temperature of approximately 10 °C (Figure 2). Pods were found in water from 5 fathoms to 180 fathoms deep, with an average depth of 36.6 fathoms (SD = 24.5). The modal depth was 30 fathoms, with 80% of pods occurring between 15 and 50 fathoms (Figure 3).

Potential humpback whale prey were shown on the echo-sounder from the water's surface to the bottom, but primarily in scattered patches or linear layers of various densities in mid-water. In most cases, prey patches appeared to be composed predominantly of fish. Whales were presumed to be feeding on the potential prey patches that were observed with the echo-sounder, although it was not possible to confirm this.

Feeding Behavior: Most whales in Glacier Bay and Icy Strait foraged alone or in groups containing 3 or fewer whales. No bubble-clouds or bubble-net feeding was observed, although whale-watching vessels reported bubble-net feeding near Pleasant

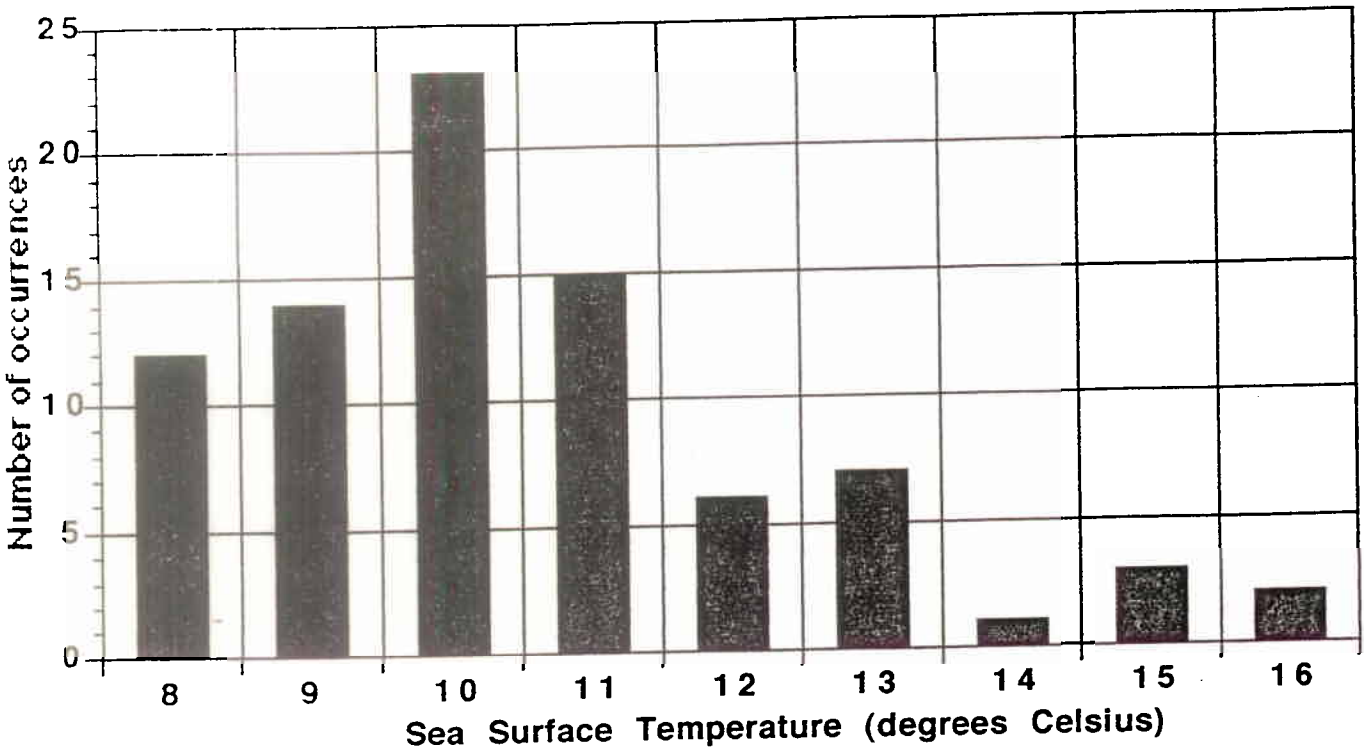

Figure 2. Sea surface temperature near humpback whale pods in Glacier Bay and Icy Strait 1994. Temperature for each of the 83 pods was rounded to the nearest degree.

island reef in late August. Although sub-surface feeding was the most common feeding mode. lateral and vertical lunge feeding were observed on several occasions near shore in Geikie Inlet and along the shores of Willoughby Island and Lemesurier Island. Echo-sounder images indicated that the target prey of the lunge-feeding animals were dense, scattered schools of fish approximately 1-3 fathoms below the water's surface. On 7 July, 10-15 whales in singles or pairs were observed lateral lunge feeding in 20 fathoms of water on patches of near-surface prey in mid-Icy Strait, approximately 3 miles WSW of Point Gustavus. Coordinated feeding by typical members of the large 'core group' (Perry et al. 1985) at Point Adolphus was observed intermittently.

A novel feeding behavior was observed on 13 July near Lemesurier Island and on 27 June near Willoughby Island. On each occasion, the whale was within 5 meters of shore and surfaced after a dive of less than 5 minutes. The whale blew once and remained stationary, flexed its tail stock with its flukes remaining underwater. The tail movement appeared to send

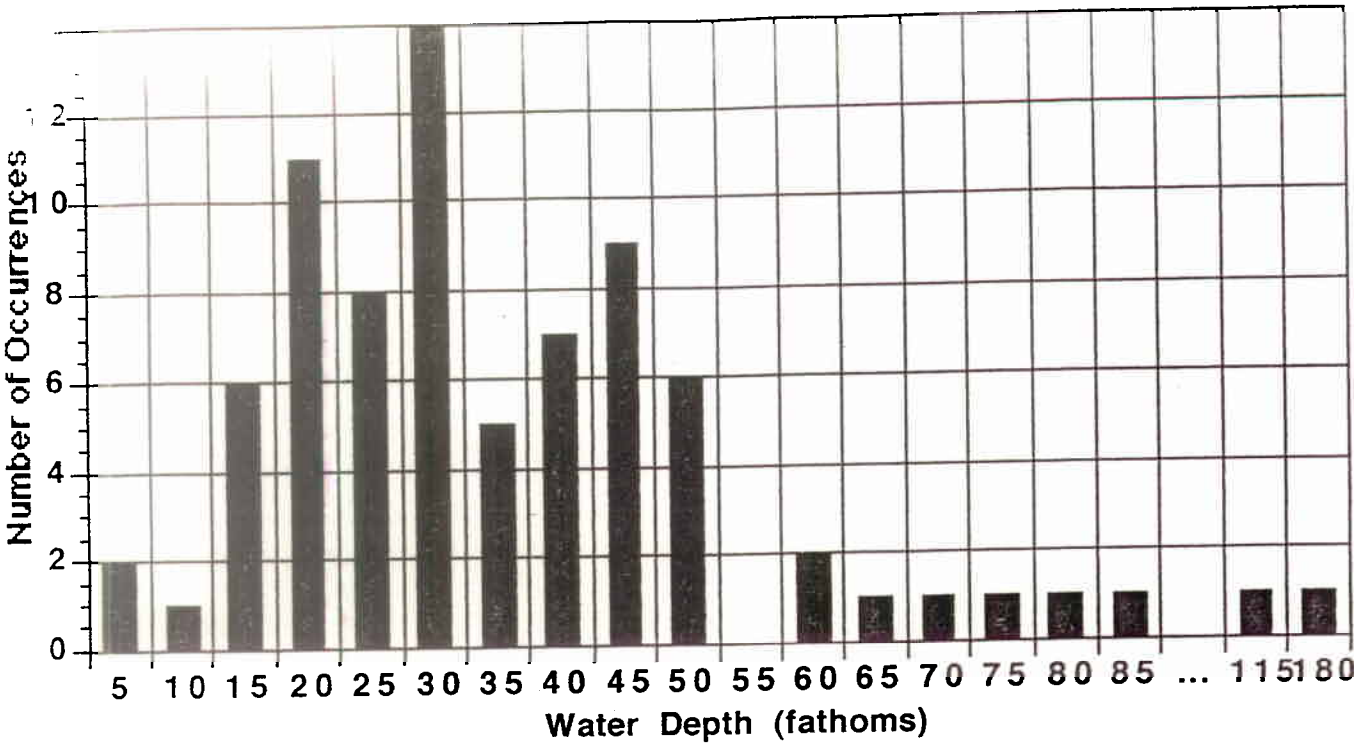

Figure 3. Water depth near humpback whale pods in Glacier Bay and Icy Strait 1994. Water depth for each of the 80 pods was rounded to the nearest 5 fathoms.

a wave of water forward toward the whale's head, and as this occurred the whale submerged and then lunged through the surface with its mouth open and its ventral pleats distended a few seconds later about 1/2 body length ahead of its last location. The whale then submerged again, came up for another blow a few seconds later, then submerged for a 3-4 minute dive, after which time the entire sequence was repeated. Dorsal fin photographs indicate that the individuals using this feeding method were 2 different whales.

Reproduction and Juvenile Survival: Nine cow/calf pairs were identified in the study area in 1994 (Table 4, Appendix 1). Cow #801 and her calf were sighted exclusively in Glacier Bay, with two cow/calf pairs identified in both Glacier Bay and Icy Strait. The remaining cow/calf pairs were sighted exclusively in Icy Strait, although cow #530 and her calf #1087 were sighted in Glacier Bay in September. Fluke identification photographs were taken of 5 calves (Table 4). Cow #581 was identified twice in Icy Strait in late June and early July, unaccompanied by a calf. However, in August, cow #581 and her calf #1089 were identified in Frederick Sound (Straley and Gabriele, unpublished data). It is unknown whether calf #1089 was present in Icy Strait in June and July.

Several whales that were first identified as calves were sighted in 1994. Whale #1019, the 1988 calf of cow #530 (Baker and Straley 1988) was identified in Icy Strait for the first time since the year of its birth. Juvenile #1064, offspring of cow #236, was also sighted for the first time since its birth year (Gabriele 1992). Ten year old cow #353 was identified with her second calf (#1085) in 1994. The crude birth rate (CBR), computed by dividing the number of calves by the total number of whales, provides a measure of the reproductive rate for the local population. The CBR for 1994 was 14.3%, continuing the long sequence of alternating high and low CBRs for the Glacier Bay/Icy Strait area (Table 5).

Table 4. Cows Identified with a Calf in Glacier Bay and Icy Strait 1994.

	Cow ID#	Calf ID#	Glacier Bay	Icy Strait
1.	155 Freckle Fluke	1084		*
2.	161 B.W.M.		*	*
3.	236 Leigh	1086	*	*
4.	353	1085		*
5.	530	1087		*
6.	573			*
7.	581	1089		~
8.	801		*	
9.	817			*

Note: Only calves whose flukes were photographed received an identification number.
* Denotes where the cow/calf pair was sighted. ~ Denotes that calf fluke was photographed in Frederick Sound.

Whale / Vessel Interactions: No humpback whale entanglements or collisions with vessels were observed or reported in Glacier Bay or Icy Strait in 1994. In Glacier Bay, vessels were reported on several occasions in close proximity to whales in Sitakaday Narrows and near South Marble Island. Whale-watching in Icy Strait was done by kayaks, skiffs, charter vessels, tour boats and cruise ships, at levels which appeared comparable to recent years. Whale watching occurred primarily near Point Adolphus, although vessels often had to search in other parts of Icy Strait because few whales were present there.

Table 5 Crude birth rate of humpback whales in Glacier Bay and Icy Strait, 82-1994

Year	#Whales	#Calves	CBR %
1982	33	6	18.2
1983	17	0	0
1984	39	7	17.9
1985	41	2	4.5
1986	51	8	15.7
1987	59	4	6.8
1988	55	8	14.5
1989	42	5	11.9
1990	50	6	12.0
1991	52	4	7.7
1992	68	12	17.6
1993	54	3	5.9
1994	63	9	14.3

Note: #Whales = total number of Glacier Bay and Icy Strait whales (including adults and calves), #Calves = number of calves, CBR % = crude birth rate, a percentage computed by #Calves / #Whales.

DISCUSSION

The number of humpback whales identified in the study area in 1994 was the second highest observed since 1985, although the proportion of resident whales was relatively low. Whale movement between Glacier Bay and Icy Strait was comparatively infrequent (Gabriele and Straley 1993). Glacier Bay whale distribution (Figure 1) was typical of previous years (Baker 1986, 1987; Baker and Straley 1988; Straley 1989, 1990; Gabriele 1991, 1992, 1993), however Icy Strait whales appeared more widely spread than usual. Whale movement and distribution within the study area are presumed to be related to prey distribution and abundance (Krieger and Wing 1986), although no recent quantitative data are available to corroborate this.

A total of 15 whales that were first identified as calves have been re-sighted in the study area since 1974 (summarized in Straley 1994), including this season's sightings of 6 year old whale #1019 and 2 year old #1064. Eight of these returnees are considered to have attained breeding age, assuming an average age at sexual maturity of 5 years (Chittleborough 1959; Nishiwaki 1959; Robins 1960; Clapham 1992a). Four of these sexually-mature whales are male (#516, #186, #352, #1014), one is female (#353), and three are of unknown sex (#349, 042, #1019). Seven returnees have not been observed past age 4 or are still too young be recruited into the breeding population. As more returning whales reach breeding age, we will continue to assess the sex ratio of recruits. The annual crude birth rate figure (Table 5)

continues to oscillate, as observed in other parts of Alaska (and von Zeigesar 1993), and to a lesser degree in the Gulf of Maine humpback whale population (Clapham 1992b).

Glacier Bay and Icy Strait humpbacks fed primarily on fish in mid-water. From the limited number of observations made of prey patch depth and feeding behavior, lunge feeding appears to be used primarily with shallow prey. The novel feeding behavior described seems functionally similar to 'flick feeding' (Jurasz and Jurasz 1979), 'lobtail feeding' (Shilling et al. 1991) and 'inside loop' feeding (Hain et al. 1982), in that the whale lunges through a prey patch that has been physically manipulated by water movement. However, the behavior described here is distinct because it was not percussive and it was performed while the whale was stationary. Two different individuals were observed feeding in this manner. Novel feeding methods appear to develop from subtle variations in the mechanics of existing methods, and may be adopted by others in the feeding herd (Schilling et al. 1991). Flexibility in feeding style would seem adaptive for maximizing feeding efficiency given the temporal and spatial variability in prey availability and behavior (Wing and Krieger 1983; Krieger and Wing 1984; Krieger and Wing 1986).

Humpbacks were found in a variety of water depths (Figure 3) and an 7.7 °C range of sea surface temperatures (Figure 2). Water depth and sea surface temperature data collected during whale observations are strictly descriptive at present, however, little prior information exists on the physical characteristics of humpback whale habitat (Jurasz et al 1981; Dolphin 1987). Moreover, even basic sea surface temperature data may gain predictive value about the distribution of whales and their prey species, because sea surface temperatures are well-correlated with water column temperatures (Royer 1989) that may influence the distribution of some species of fish and crustaceans (Muter et al. in press). Sustained quantitative studies of Glacier Bay marine ecology, combined with basic physical oceanographic data would provide a much clearer context in which to interpret humpback whale distribution and numbers. Without long-term oceanographic and whale prey data we cannot adequately explore the potential link between whale distribution and changing human use of Glacier Bay, Icy Strait and southeastern Alaska.

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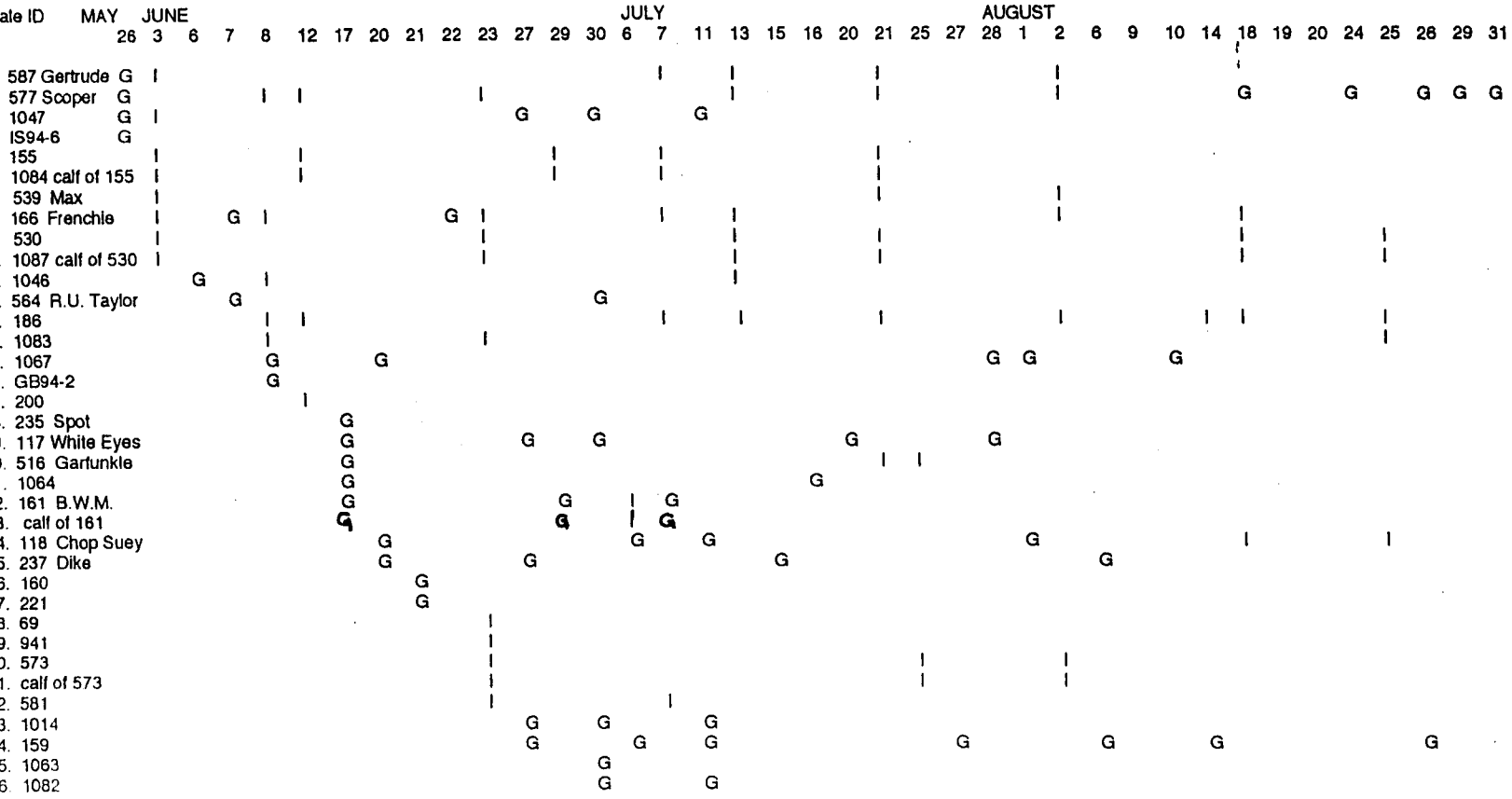
PENDIX 1. HUMPBACK WHALE SIGHTING HISTORIES 1994



Note: G = Glacier Bay sighting, I = Icy Strait sighting. Appendix 1 continues on the next page.

APPENDIX 1. continued HUMPBACK WHALE SIGHTING HISTORIES 1994

Whale ID	MAY													JUNE												JULY												AUGUST											
	26	3	6	7	8	12	17	20	21	22	23	27	29	30	6	7	11	13	15	16	20	21	25	27	28	1	2	6	9	10	14	18	19	20	24	25	26	29	31										
37. GB94-5														G																																		
38. 351														G															I		I	I																
39. 353																I		I				I					I																					
40. 1085 calf of 353																I		I				I					I																					
41. IS94-7 calf																I																															
42. 1042																I																															
43. 566 Curly Fluke																I																															
44. 513																I																															
45. 875																I																															
46. 801																	G										G																			
47. calf of 801																	G										G																			
48. 616 Lesser																		I																													
49. 1019																		I																													
50. 236 Leigh																		I								G	I					G	G	G			G	G	G						
51. 1088 calf of 236																		I								G	I					G	G	G			G	G	G						
52. 817																		I																													
53. calf of 817																		I																													
54. 219																		I				I																								
55. 441																		I																													
56. 157 M.D.																		I					I						I																
57. 352																						I								I															
58. 1012																										G				G							G								
59. IS94-3																											I																			
60. IS94-4																											I																			
61. 1061																											I																			
62. 1018																					G							G								G		G							
63. GB94-4																																					G									

Note: G = Glacier Bay sighting, I = Icy Strait sighting. Appendix 1 is continued from the previous page.